CLAIMS

What is claimed is:

1. A fuel processor for rapidly achieving operating temperature, said fuel processor comprising:

a reformer converting a hydrogen-containing fuel to H_2-containing reformate;

a shift reactor in fluid communication with said reformer, said shift reactor being operable to reduce carbon monoxide levels of said reformate;

a preferential oxidation reactor in fluid communication with said shift reactor, said preferential oxidation reactor being operable to further reduce carbon monoxide levels of said reformate exiting said shift reactor; and

a first combustion heater system coupled to at least one of said reformer, said shift reactor, and said preferential oxidation reactor, said first combustion heater system being operable in a lean state to produce thermal energy as a product of the combustion of air and fuel in the form of a first heated exhaust stream.

2. The fuel processor according to Claim 1, further comprising:

a second combustion heater system coupled to at least another of said reformer, said shift reactor, and said preferential oxidation reactor, said second combustion heater system being operable to produce thermal energy as

a product of the combustion of air and fuel in the form of a second heated exhaust stream.

3. The fuel processor according to Claim 2, wherein said second combustion heater further comprises an air inlet providing fresh air thereto.

4. The fuel processor according to Claim 2, wherein said second combustion heater system is positioned in series with said first combustion heater system.

5. The fuel processor according to Claim 4, wherein said second combustion heater further comprises a first inlet providing fresh air thereto and a second inlet in fluid communication with said first heated exhaust stream.

6. The fuel processor according to Claim 5, wherein said first heated exhaust stream is used to dilute said fresh air to control the temperature of said second heated exhaust stream.

7. The fuel processor according to Claim 2, further comprising:

a control valve system selectively diverting said first heated exhaust stream from said first combustion heater system from passing through said shift reactor.

8. The fuel processor according to Claim 2, further comprising:

a heat exchanger operatively associated with at least one of said reformer, said shift reactor, and said preferential oxidation reactor, said heat exchanger being exposed to at least one of said first heated exhaust stream and said second heated exhaust stream for heating said at least one of said reformer, said shift reactor, and said preferential oxidation reactor.

9. The fuel processor according to Claim 2, further comprising:

a water spray member coupled downstream from said second combustion heater system, said water spray member being operable to maintain a predetermined temperatures of said second heated exhaust stream.

10. The fuel processor according to Claim 2, further comprising:

a control valve system selectively routing an O_2-containing cathode effluent from a fuel cell stack to a catalyst combustor and said second combustion heater system.

11. The fuel processor according to Claim 10, wherein said control valve system comprises:

a combustor air control valve selectively routing one of a group consisting of air and said O_2-containing cathode effluent to said catalyst combustor; and

a cathode back pressure valve selectively applying a fluid back pressure to facilitate routing of said O_2-containing cathode effluent to said catalyst combustor.

12. The fuel processor according to Claim 2, wherein said combustion of said air and said fuel in said first combustion heater system is lean of stoichemetric condition and said combustion of said air and said fuel in said second combustion heater system is generally near ideal stoichemetric condition.

13. The fuel processor according to Claim 2, further comprising:

a catalyst combustor positioned in series upstream from said second combustion heater system.

14. The fuel processor according to Claim 2, further comprising:

a catalyst combustor positioned in series downstream from said second combustion heater system.

15. The fuel processor according to Claim 2, further comprising:

a catalyst combustor positioned such that an output of said catalyst combustor is input downstream of said second combustion heater system.

16. A fuel processor comprising:

a reformer converting a hydrogen-containing fuel selected from the group consisting of alcohol and hydrocarbons to H_2-containing reformate;

a shift reactor in fluid communication with said reformer, said shift reactor being operable to reduce carbon monoxide levels of said reformate;

a preferential oxidation reactor in fluid communication with said shift reactor, said preferential oxidation reactor being operable to further reduce carbon monoxide levels of said reformate exiting said shift reactor;

a first combustion heater system coupled to at least one of said reformer, said shift reactor, and said preferential oxidation reactor, said first combustion heater system being operable in a lean state to produce thermal energy as a product of combustion in the form of a first heated exhaust stream; and

a second combustion heater system coupled to at least another of said reformer, said shift reactor, and said preferential oxidation reactor, said second combustion heater system being operable in a slightly lean state to produce thermal energy as a product of combustion in the form of a second heated exhaust stream.

17. The fuel processor according to Claim 16, wherein said second combustion heater further comprises an air inlet providing fresh air thereto.

18. The fuel processor according to Claim 16, wherein said second combustion heater system is positioned in series with said first combustion heater system.

19. The fuel processor according to Claim 18, wherein said second combustion heater further comprises a first inlet providing fresh air thereto and a second inlet in fluid communication with said first heated exhaust stream.

20. The fuel processor according to Claim 19, wherein said first heated exhaust stream is used to dilute said fresh air to control the temperature of said second heated exhaust stream.

21. The fuel processor according to Claim 18, further comprising:

a first control valve system selectively routing said first heated exhaust stream to said second combustion heater system during a startup cycle.

22. The fuel processor according to Claim 16, further comprising:

a water spray member coupled downstream from said second combustion heater system, said water spray member being operable to maintain a predetermined temperatures of said second heated exhaust stream.

23. The fuel processor according to Claim 16, further comprising:

a second control valve system selectively routing an O_2-containing cathode effluent from a fuel cell stack to a catalyst combustor and said second combustion heater system.

24. The fuel processor according to Claim 23, wherein said second control valve system comprises:

a combustor air control valve selectively routing said O_2-containing cathode effluent to said catalyst combustor; and

a cathode back pressure valve selectively applying a fluid back pressure to facilitate routing of said O_2-containing cathode effluent to said catalyst combustor.

25. The fuel processor according to Claim 16, further comprising:

a catalyst combustor positioned in series upstream from said second combustion heater system.

26. The fuel processor according to Claim 16, further comprising:

a catalyst combustor positioned in series downstream from said second combustion heater system.

27. The fuel processor according to Claim 16, further comprising:

a catalyst combustor positioned such that an output of said catalyst combustor is input downstream of said second combustion heater system.

28. A fuel processor comprising:

a reformer converting a hydrogen-containing fuel selected from the group consisting of alcohols and hydrocarbons to H_2-containing reformate;

a shift reactor in fluid communication with said reformer, said shift reactor being operable to reduce carbon monoxide levels of said reformate;

a preferential oxidation reactor in fluid communication with said shift reactor, said preferential oxidation reactor being operable to further reduce carbon monoxide levels of said reformate exiting said shift reactor;

a first combustion heater system coupled to said reformer, said first combustion heater system being operable to produce thermal energy as a product of combustion in the form of a first heated exhaust stream; and

a second combustion heater system coupled to said shift reactor, said second combustion heater system being operable to produce thermal energy as a product of combustion in the form of a second heated exhaust stream.

29. The fuel processor according to Claim 28, wherein said second combustion heater further comprises an air inlet providing fresh air thereto.

30. The fuel processor according to Claim 28, wherein said second combustion heater system is positioned in series with said first combustion heater system.

31. The fuel processor according to Claim 30, wherein said second combustion heater further comprises a first inlet providing fresh air thereto and a second inlet in fluid communication with said first heated exhaust stream.

32. The fuel processor according to Claim 31, wherein said first heated exhaust stream is used to dilute said fresh air to control the temperature of said second heated exhaust stream.

33. The fuel processor according to Claim 30, further comprising:

a first control valve system selectively routing said first heated exhaust stream to said second combustion heater system during a startup cycle.

34. The fuel processor according to Claim 28, further comprising:

a water spray member coupled downstream from said second combustion heater system, said water spray member being operable to maintain a predetermined temperatures of said second heated exhaust stream.

35. The fuel processor according to Claim 28, further comprising:

a second control valve system selectively routing an O_2-containing cathode effluent from a fuel cell stack to a catalyst combustor and said second combustion heater system.

36. The fuel processor according to Claim 28, further comprising:

a catalyst combustor positioned in series upstream from said second combustion heater system.

37. The fuel processor according to Claim 28, further comprising:

a catalyst combustor positioned in series downstream from said second combustion heater system.

38. The fuel processor according to Claim 28, further comprising:

a catalyst combustor positioned such that an output of said catalyst combustor is input downstream of said second combustion heater system.